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Quality Challenges of Indian Shrimps: A View from Odisha

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Abstract

Shrimp farming over the years has witnessed unprecedented growth because of increasing international demand. The greater acceptability and consumer preferences have also been accompanied by growing concerns about the quality of traded shrimp. Quality issues can manifest through physical attributes like colour, texture, smell as well as more importantly food safety. This paper has attempted to identify these challenges by studying select villages in the district of of Balasore in the State of Odisha. The Objective of the paper is to investigate the quality challenges arising from shrimp farming in the observed area. The study adopts a mixed method approach to gain insights into the quality issues in shrimp farming. This approach combines quantitative data analysis with qualitative discussions to provide a comprehensive understanding of the challenges faced. The study found prevalence of bacterial diseases in farmed shrimp in the observed area. The increasing incidence of these diseases and the use of antibiotics are attributed to environmental factors such as climate, water pollution and deficient farming practices

1. Introduction

Odisha has a coastline of 480 km with a continental shelf of 24000 sq. km and is a major marine producing state of India. Odisha is the fourth largest fish producing State of the country. As per Government of Odisha Data of 2019-20 brackish water aquaculture of the State is 15,045 ha with a production figure of 90000MT. During the last twenty years the shrimp sector has grown at CAGR 16%.{1} The marine has grown substantially from INR 379 crore in 2000-2001 to INR 4500 crore in 2022-2023.{2} Nearly 70% of these export revenues come from the shrimps only.{3} But the growth of shrimp demand has accompanied with increasing quality concerns in recent times. This paper studied the quality issues and challenges faced by the farmers doing shrimp farming in Balasore district. This topic was chosen because of the contemporary relevance arising out of international concern regarding the quality issues involving traded shrimp. Though few studies have explored the shrimp farming evolution and environmental effects in the State of Odisha but no concrete study has been done on the quality issues involving cultivated shrimp. For example, (Chhotray,2022:) (4) investigated the environmental effects of shrimp farming and large-scale diversion of fertile paddy lands for shrimp farming in the State. Similarly (Kar, B, Tripathy, S,2020:) (5) examined the evolution of shrimp farming in the State from 1970 to current period highlighting the progress of the sector in the State. A few of the reports like FAO, Central Institute Of Brackish Water Aquaculture (1991) (6) focused on the issues like evolution of shrimp industry and confined pond shrimp farming in Chilika.The Government Of Odisha annual Fisheries reports also give insightful view on the progress of marine industry in the State. Despite these studies there remains a lack of comprehensive research on the quality challenges specific to shrimp farming practices in Odisha. Previous research has primarily focused on the growth of industry leaving a gap in our understanding of specific mentioned issue which has a larger effect and impact on shrimp export from the State. Traditionally the farmers in Odisha used to trap shrimp from tidal waves and ponds near the coast. All the shrimps thus trapped used to be supplied in the local market. Consequently, the cultivation of shrimp started taking place with increased demand from outside India. The coastal Rice lands which were basically used for mono crop rice farming were utilized simultaneously for shrimp farming also. In this Rice-Shrimp farming system consequent to rice harvest the fields are irrigated with high saline river water and wild shrimp larvae were captured and released into the fields.{7} As it was a period of limited economic activity large scale shrimp farming was neither desired nor attempted. Though the breakthrough for increased cultivation had already set its base in 1934 through Dr. Fujinaga revolutionary research work where he had induced Kuruma shrimp to spawn under laboratory condition.{8} India has been a late starter in adopting to this intensive cultivation as compared to other South East Asian countries.{9} The Eighties saw for the first time the emergence of commercial cultivation of shrimps in Odisha. But the evolution of semi and intensive shrimp farming has been slow as India primarily depended on wild caught Penaeus Monodon (Black Tiger) and Fenneropenaeus indicus (Indian White Shrimp) for its export requirements. The growth of Global shrimp industry came to a standstill in early part on Nineties due to a bacterial attack known as White Spot Disease. This disease swept across South East Asia and created a major perception about the possible detrimental environmental effects of shrimp farming. Though India was primarily immune from this disaster the top court of India Supreme Court Of India through its landmark decision S.Jagannath vs Union Of India & Ors (Dec 1996) restricted the shrimp farming within Coastal regulation zone up to 500 mtr from the waterline along the Sea.{10} The disaster forced the shrimp breeding companies to look for safer alternatives. This led to the discovery of Specific pathogen free strain Litopenaeus Vannamei or pacific white shrimp. This specie is native to Eastern pacific- ocean and currently is the highest farmed shrimp across the World including India.{11} India allowed this specie in 2008 and consequently the shrimp cultivation and exports from India has increased substantially.{12} As per Government Of India report 1,08,526.27 ha is under Vannamei culture in nine maritime states producing 8,15,745 MT{10} Though Black Tiger and Fresh water shrimps continued to be produced and exported this SPF (pathogen free} white shrimp with its ability to withstand diseases as compared to other shrimp species ,faster growth rate and its adaptability to varied environmental conditions resulted in rapid increase in its production as well as exports.{13} India's Sea food exports for the year 2022-23 was Rs 63,969.14 crore with frozen shrimps contributing the largest percentage 40.98% (Rs 43,135.58 crore).{14} The global shrimp market is projected to reach $53.63bn by 2028 at a CAGR of 6.8% during the period of 2021-2028.{15} The increased affordability of people, lifestyle changes and increased visibility of "HORECA" (Hotel, Restaurant, Cafe segment) would in all probability lead to an increased demand for shrimps going ahead. [1] So, the demand for Vannamei shrimp which currently holds the world market share of 45.3% in 2022 is going to further increase.{16} As the following table clearly demonstrates except for the year 2020-21 where the demand from the world market shrunk because of pandemic, India was still able to produce and market more. [2-7] Figure 1 and Table 1 shows the Indian Shrimp Export (2018-2023).

Table 1 Indian Shrimp Exports-A Rising trend (2018-2023)

	2018-19	2019-20	2020-2021	2021-2022	2022-2023
Quantity	614145 (MT)	652253	590275	728123	711099
Value INR	31880.51	34152.03	32520.29	42706.04	43135.58
Value $	4.610.59 mn	4.889.12	4.426.19	5.589.29	5.481.63

MPEDA, Government of India {17}

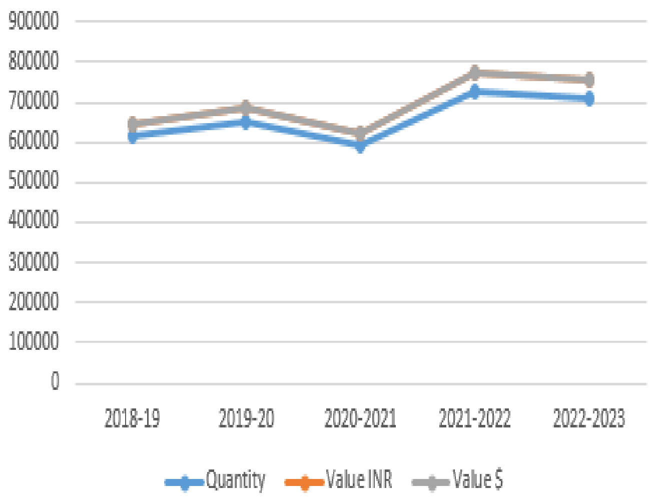

Figure 1 Indian Shrimp Exports – A Rising Trend (2018-2023)

1.1 Quality Challenges

But India's as well as Odisha shrimp exports are facing increasing challenges as shown in Table [2-5]. These can be broadly classified as (a) Quality challenges, (b) increased Cost of production issues, (c) Environmental & Sustainability challenges and (d) Difficult International trade dynamics. This paper has analed the quality challenges involving the shrimp cultivation and consequent trade. Quality issue directly affect the shrimp trade, lowering the value of the product and raising doubts about the dependability of the supplier.{18} The quality concerns can broadly cover the physical aspects like colour,smell and texture as well as the factors involving food safety.The following factors have an undesirable effect on the quality of the shrimp.{19}

Table 2 Quality Challenges

Pathogen contamination	Bacterial, viral or parasitic pathogens
Chemical treatments of ponds	Residues remain in the shrimp
Toxin production	Diseases led toxin stay within the shrimps
Cross contamination	Can serve as a source of contamination for healthy shrimps
Impact on quality	These factors affect the shrimp texture, odour and colour

Table 3 Quality Concerns Vs. Physical Defeats

Quality concerns	Physical defeats
Appearance	Melanosis (Black Spots), Shell discoloration, Broken or missing appendages, soft shells, loose head, Red head, Yellowing
Odor/flavour	Sour smell, Earthy flavour, Rancid flavour, Chemical Odor, fishy Odor, moldy smell
Texture	Mushy texture, Rubbery, dry, uneven texture, crystalline.
Processing defects	Incomplete deveining, improper peeling, Broken shrimp, Incorrect glazing, Inadequate washing, residual chemicals, Poor packaging, Inconsistent sizing, foreign Matter contamination, Temperature abuse.
Source: Aqua Docs {20}	

As quality and physical factors are closely related it is necessary to have a close look on the issue for better understanding. It is pertinent to note that these quality defects emerge as a result of combination of factors including environmental factors like climate, water pollution and other issues. This has resulted in increased disease prevalence in the shrimps and has also resulted in the use of antibiotics. So, the combination of disease and antibiotic use has also given rise to more dangerous issues like antibiotic residues in the shrimp and anti-microbial resistance. So, the quality concerns have become much wider in scope linking all these possible variables. A possible list of factors which contribute to the quality deficiency have been highlighted in the table below. [8-13]

Table 4 Nature of Variables Vs. Quality Challenges

Nature of Variables	Quality Challenges
Water Pollution	Disease outbreak. Use of antibiotics, Lower productivity
Climate & Climatic change (High temperature, Excessive rains, prolonged dry conditions)	increased disease outbreak Bacteria Like Vibrio thrive in high temperature and absence of oxygen
Poor Farm Practices Inadequate water exchange in the pond, excessive use of chemicals, sub optimal or overuse of feed, No proper soil testing, In adequate separation from the surrounding paddy lands, Discharge of polluted water from the pond, presence of higher organic matters, Absence of bio safety protocols.	Increased disease outbreak

Thus, increased disease outbreak because of these assortments of factors necessitates the use of preventive measures like antibiotics to limit the damage. But it should be made clear that use of antibiotics within permissible levels are not dangerous but the issues like (a) residues in the shrimp (b) Antibiotic resistance (c) environmental impact (d) impact on shrimp health (e) Regulatory compliance (f) quality perception have gained prominence. In this context the outbreak of various diseases is attributed to sub-par quality shrimps' consumption across the world.

Table 5 Common Diseases Vs. Nature of Food Borne Illness

Common Diseases	Nature of Food Borne Illness
Vibrios infections	Gastroenteritis: Diarrhoea, abdominal cramps, nausea, vomiting, fever, chills, Extreme case bloodstream infections.
Salmonella	Diarrhoea, fever, and abdominal cramps
Listeriosis	Dangerous for pregnant women, newborns and elderly. Fever, muscle aches
Hepatitis A	Fever, fatigue, Loss of Appetite, nausea Vomiting, dark urine, jaundice, liver issues
Norovirus	Gastroenteritis and its characteristics
Parasitic infections	Nausea, vomiting, pain
Allergic reactions	Flushing, headaches, cramps
Chemical contamination	Allergic reactions, antibiotic resistance, long term health effects.

(Source: Johnson,S.K., Handbook of Shrimp Diseases {22} Davares et al [23])

2. Materials and Methods

2.1 Study Area

The paper focused on select villages of Balasore district which is one of the leading marine resource districts of province of Odisha. Odisha has a coastline of 480 km with a continental shelf of 24000 Sq. Km. It is the Fourth Largest Fish producing State in India with a production of 8.16 lakh MT in 2019-20. Shrimps constitute the major share of this production and primarily exported out of the province. This study was done in six villages of Balasore district that are primarily engaged in shrimp cultivation since last two decades. The district which has a coastline of 80km along the Bay of Bengal is currently on the forefront of shrimp cultivation in the State.[24] Figure 2 shows map of Balasore.

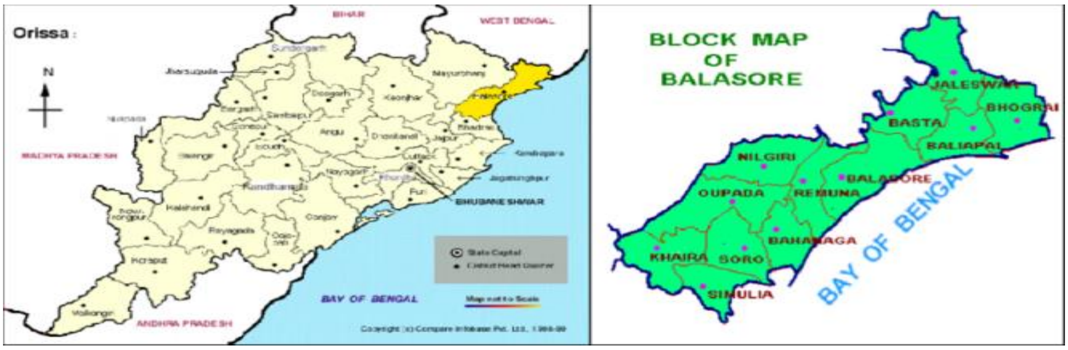

Figure 2 **Block Map of Balasore**
(Source: Google Maps)

As mentioned, quality concerns in shrimp usually covers a wide range of issues but it's the bacterial diseases and therapeutic agents which have has taken the center stage in the shrimp cultivation currently in the world. The current study also found ample evidences of these concerns. As shrimp procurement activity moved from the natural habitat to controlled farming conditions due to increased demand in the international market the bacterial diseases have become more common.{25} The shrimps are exposed to external environmental conditions as a result of which bacterial and Viral diseases are commonly found in the cultured Penaeid in the Larval, Post Larval and juvenile stage. These became responsible for diseases and higher mortality. Though the Penaeid get affected by various bacterial diseases few of the following diseases stand out with regard to their potential dangerous impact. One of the most cited bacterial diseases across the world has been VIBRIOS. This bacteria can grow in the absence of Oxygen and always thrive in higher temperatures and cause higher mortality among Penaeid. The second most damaging bacterial disease is commonly known as Early Mortality Syndrome (EMS) OR AHPND (Acute hepatopancreatic Necrosis disease). This particular disease destroyed Thailand shrimp farms between the period from 2009-2015 and has now emerged as the single most damaging bacterial disease affecting the shrimps and their large-scale mortality. As Vi brio is responsible for AHPND one can safely assume the impact of the second disease on shrimp farming. The third most commonly referred bacterial disease is the WHITE SPOT SYNDROME VIRUS (WSSV). Though it is a virus but secondary bacterial infections often occur in shrimp affected by WSSV. In fact this specific study found out the prevalence of WSSV in the observed area. Similarly, diseases like Necrotizing Hepatopancreatitis OR NHP and Enterocytozoon Hepatopenaei OR EHP have struck shrimp farming in different countries.{26} In India apart from the above-mentioned bacterial diseases other diseases like White Feces disease, Black Gill disease and chronic soft-shell syndrome have created problems for shrimp cultivators. These diseases have resulted in farmers using antibiotics. The most discussed problem is with regard to antibiotic residues. Antibiotic residues not only affect human health in the form of allergies and other damaging health issues like cancer, reproductive disorders, bone marrow toxicity but also induces antibiotic resistance. This is turning out to be most dangerous as community health is at risk. (27)A look at India's export consignments rejection over the years substantiate this point. [14-18]

Table 6 **Indian Shrimp Export Consignments Refusals in USA**

Notifications and Refusals per $ 100mn of Shrimp exports (2015-18)	USA	EU
India	0.49	0.6
Vietnam	0.11	0.1
Ecuador	0.29	1.7
China	0.08	0.2
Thailand.	0.02	0

(Source: High Level Expert Group Report of Govt. of India. July 2020{28})

The notifications and refusals for India have been high in USA in the stated period as compared to other countries as shown in Table 6. These refusals are because of presence of antibiotics, bacterial contamination and salmonella. This becomes more significant as India exports 40% of shrimps to USA. In May 2023 the US Food and Drug Administration gave details of 103 Seafood entry line refusals out of which 2.9% were relating to banned antibiotics. (29).In fact disease management has to center around responsible use of antibiotics based on rules and regulations.[30]

2.2 Sampling & Measurements

The study utilized simple random sampling involving Fifty Farmers from Six villages of two blocks Bahanaga and Baliapal of Balasore district. Ten number of farmed ponds of one acre each were taken for observation for possible disease infestation and use of antibiotics and also effect of climate on the shrimp health. These variables were chosen to understand the implication of quality through observing the shrimp production process as practiced in the concerned area.

2.3 Results & Discussions

The study used Pearson co relation coefficient to establish the strength of the linear relationship between Antibiotic usage and diseased shrimp in the cultivated pond and whether the extent of antibiotic use in the form of medicated feed and the number of bacterial affected shrimps are high enough to draw some definitive conclusions. Similarly, the study wanted to establish a linear relationship between climate conditions prevailing in the production months (Apr-June 2022) and the extent of disease in the pond farms to find out the impact of weather on the health of the shrimps. For the first co relation the data set was collected from 10 number of ponds in the study area. As antibiotics were not directly applied by the farmers and it was through medicated feeds the disease prevention was sought to be addressed the research wanted to ascertain the quantity of feed used to obtain the results. The study wanted to build a co relation between the quantity use of the feed and the number of diseased shrimps in ten number of ponds to highlight the effects of antibiotics on shrimp disease management. The antibiotic usage was basically calculated from the feed that was given to one lakh stockings in these observed plots. Each shrimp weighed on an average 10 grams then the total bio mass is 100,000 shrimp@0.01kg (10 grams converted to kilograms= 1000kg. The feed rate is 5% of the shrimp bio mass and the daily feed requirements of these farms are 50kg as shown in Table 7. [19-23]

Table 7 Use of Antibiotics (Per Kg)

Pond (1acre size)	Use of Antibiotics (per kg) As Calculated from Geed Given. (50kg per day @ 30 = 1,500 kg)	Disease Affected Shrimps in The Pond
Plot no 1	6 KG	3000
Plot no 2	5 KG	5000
Plot no 3	4 KG	3000
Plot no 4	5 KG	4000
Plot no 5	5 KG	2000
Plot no 6	7 KG	4000
Plot no 7	6 KG	1500
Plot no 8	5 KG	2000
Plot no 9	5 KG	2500
Plot no10 Data collected for the year 2022 for the month of June and the figure may vary.	6 KG	2000

The Mean AU (Antibiotic usage) = 5.4 kg and mean NDS (Number of diseased shrimps) = 2000 shrimps. The Co variance between (cov) AU and NDS is 122.22. The SD AU is 0.711 approximately and SD NDS is 2011833.33 approximately. The Co relation of Coefficient is 0.00329. So, the co-relation coefficient between antibiotic usage and the number of diseased shrimps indicates a very weak negative co relation between the two variables. [14-27]

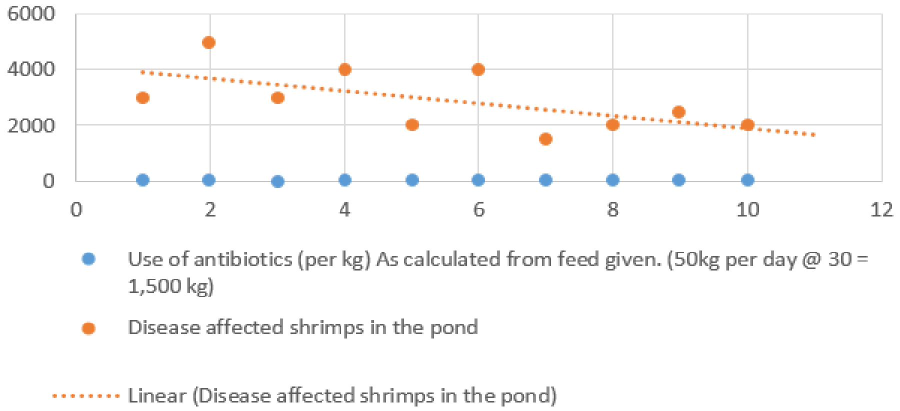

Figure 3 Use of Feed Containing Antibiotics & Occurrence of Shrimp Bacterial Disease

Table 4 Regression Analysis of Weather Parameters and Shrimp Health in A Specific Plot Of 1 Acre (April-June 2022) The Water Parameters Available for The Months of (Apr-June'2022) at Balasore.

	Avg. Temperature	Avg. Humidity	Precipitation
Apr	30.9	67.6	0
May	30.5	71.2	72.13
Jun	30.3	75	44.96

(Source: https://en.tutiempo.net/climate/2022/ws-428950.html)

Table 5 Regression Analysis of Weather Temperature and Diseased Shrimps in A Specific Plot of 1 Acre (April-June 2022)

	AV Temperature (x)	Number of diseased shrimps	Regression Analysis (y)
Apr	30.09	0	
May	30.05	750	
June	30.03	1750	Y = 80114.22 x + 2408565.03

The regression equation for temperature and the number of diseased shrimps is Y=80114.22x+2408565.03. This slope (80114.22) This suggests a positive association between these two variables.

Table 6 Regression Analysis of Weather Humidity and Diseased Shrimps in A Specific Plot of 1 Acre (April-June 2022)

	AV Humidity	Number of diseased shrimps	Regression Analysis
Apr	67.6	0	
May	71.2	750	
June	75	1750	Y = 45.72x + 4100.10

The regression equation between humidity and diseased shrimp is approximately Y = 45.72x+4100.10. This suggests a positive relationship between humidity and the number of diseased shrimps. [28]

Table 7 Regression Analysis of Weather Precipitation and Diseased Shrimps in A Specific Plot of 1 Acre (April-June 2022)

	AV Precipitation	Number of diseased shrimps	Regression Analysis
Apr	0	0	
May	72.13	750	
June	44.96	1750	$Y = 40.41x - 743.61$

The regression equation of precipitation and the number of diseased shrimps is approximately

$$Y=40.41x-743.61$$

This equation suggests a positive relationship between precipitation and the number of diseased shrimps. The study found out negative co relation between quantity of antibiotic usage and the number of diseased shrimps. An analysis of the same lead to following interpretations

(A) The negative co-relation demonstrates limited effectiveness of anti-biotics in controlling the bacterial disease

(B) It might also be interpreted as sub optimal use of medicated feeds because of poor economic conditions which could have resulted in reduced effectiveness

(C) A weak co relation might also mean the presence of resistant strains rendering the effectiveness of antibiotics

(D) The regression analysis of temperature, humidity, rainfall and shrimp health found a positive correlation. Some of the interpretations of this positive correlation leads to a conclusion that warm temperature create conditions that are favorable for the growth and proliferation of pathogens. Temperature change can also influence various environmental factors within the pond like water quality, oxygen levels and microbial activity. Similarly higher humidity leads to increased disease. And the relationship between precipitation and increased disease is established. Increased precipitation changes water quality parameters like PH, nutrient concentration and dissolved oxygen which can unsettle ponds internal condition. Excessive rains can create environmental conditions like influencing pond waterflow and the external contamints into pond environment.

The study also conducted Focused Group Discussions regarding the dynamics of shrimp farming and effect and importance of quality in shrimp farming. The FDGs primary aim was to gather insights on shrimp farming practices, economic considerations as well as environmental effect.

3. Methodology

The FDGs involved shrimp farmers, local PRI members, Exporters agent, input suppliers and block officials.

Data collection: semi structured discussion guide involving topics like use of antibiotics in shrimp farming, using other sustainable strategies to reduce the use of antibiotics, Government export policies, and climate change challenges.

Data analysis: Qualitative data from the FDGs were transcribed, coded and thematically analyzed

3.1 Key Findings from FGD

(a) Farming Practices

The participants were aware of the negative impact of antibiotic use and were concerned about increasing challenge of disease infestation. They have started implementing some of the sustainable measures like use of Pro biotics to increase the growth of beneficial bacteria to control the bad ones. They realize the importance of water exchange and the farmers have started installing aerators. Due to electricity problem to run the generators they have started exploring solar power technology provided the Government take the initiative to help them financially. The recurrent effect of cyclone has made them think to raise their embankments and also access weather information on a regular basis. The participants felt that bio security measures have to be strengthened to keep their ponds relatively disease free. The mangrove preservation was also highlighted. [29]

(b) Environmental Concerns

The water pollution, land degradation and habitat loss were the main concerns among the participants. The participants felt that stricter regulations should be in place to prevent farm sewage getting into water bodies of the adjacent areas. Though regulations are already in place but still a concerted effort should be put in place to limit these damages.

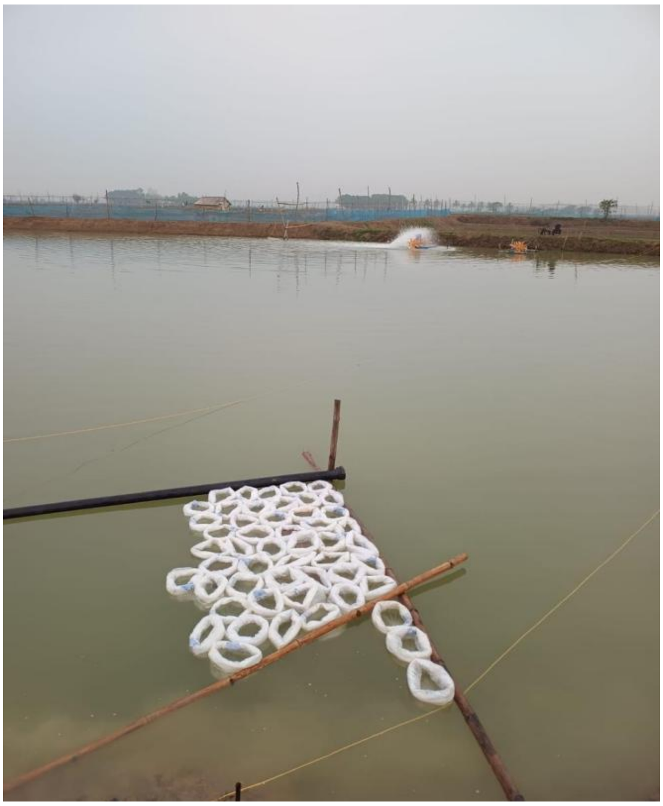

Figure 3 Vannamei Shrimps - Introduction to Pond at The Studied Area

(c) Stakeholder Interactions

The participants felt that the Government agencies should do more with regard to rules and regulations involving shrimp farming so that their produce can compete outside. The exporter's role is very critical with regard to the quality of the produce. Newer trends and opportunities should be also shared with the farmers, Conclusion: The FDGs provide valuable perspectives. The report highlights the importance of regular interactions among the stakeholders and importance of ensuring safe shrimp farming for the consumers. The exporters and the Government organizations like MPEDA have taken the lead. But the report finds increasing cost of production as a hindrance for successfully competing in the International Market. Quality issues and cost of production are the main challenging point currently. The widespread fluctuation of Farm gate prices because of difficult international market continue to create problems for the small farmers.

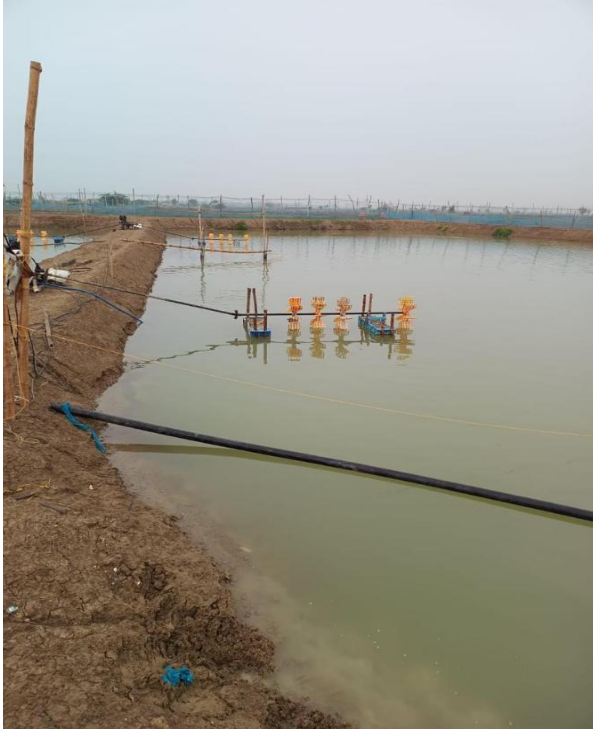

Figure 4 Vannamei Shrimps - Introduction to Pond at The Studied Area

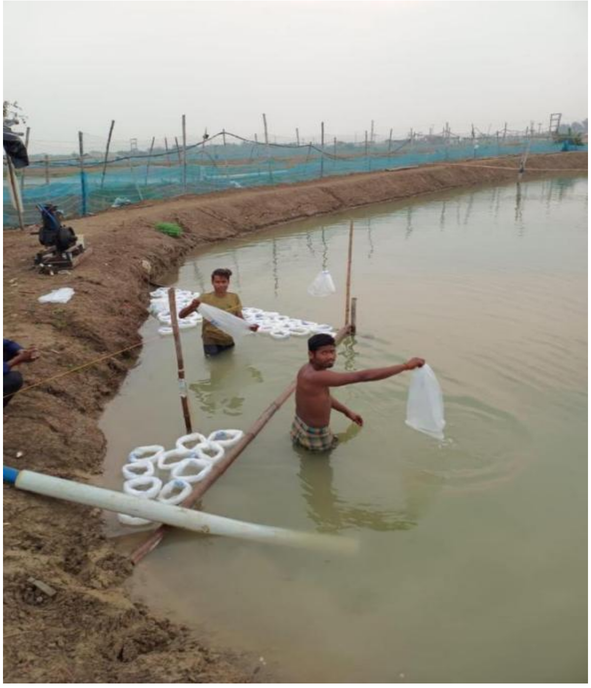

Figure 5 Vannamei Shrimps - Introduction to Pond at The Studied Area

Conclusion

The Indian shrimp sector challenges have led the stakeholders to initiate sustainable practices to bolster its competitive advantage. The competitive advantage can only be ensured if sufficient attention is given to various emerging environmental issues.

The premier status of India as a major shrimp exporting country can be well served if important issues involving the current international trade can be tackled on priority basis. The importing countries are also working closely with India to improve shrimp quality through adoption of technology and other practices thus promoting safe shrimp trade. As the shrimp industry poised to grow further understanding and managing the issues involving shrimp farming in India has become crucial and pertinent.

Conflict of Interests

The authors declare that they have no conflict of interests.

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